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Energy Procedia 100 (2016) 54 – 64

Energy Procedia

3rd International Conference on Power and Energy Systems Engineering, CPESE 2016, 8-12 September 2016, Kitakyushu, Japan

Daylight Factor Estimation Based on Data Sampling Using Distance Weighting

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Abstract

Many of the architectural design which incorporates natural light through the window design based on assumptions and empirical review that is not measurable. The entry of natural light into the space affects the level of energy efficiency to the use of artificial lighting. The large number of lumens from the light source that will fall on the surface of the room on every square feet (sq ft) would affect the value of illumination in the room. This study was conducted to determine the size of the lighting distribution of sunlight in the room. The method used is the direct measurement in the study area, collecting measurement data and map the numbers into a formula the density distribution of incoming light by using a mathematical equation to further simulate the density distribution of daylight that enters the room apartments and distribute the value of illumination with daylight factor. Simulation of light distribution daytime (daylight) used a simple method, which can result shows the distribution of light from the highest intensity to the lowest intensity. The results showed that the value of the existing distribution are useful to conduct a study follow-up study on the distribution of light in the room. Illumination distribution is expected to be useful for the design of spatial structure for architects.

Peer-review under responsibility of the organizing committee of CPESE 2016

Keywords: *natural lighting, illumination distribution, daylight factor.*

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Peer-review under responsibility of the organizing committee of CPESE 2016
doi:10.1016/j.egypro.2016.10.153

1. Introduction

Natural lighting or daylighting is a source of light for the full spectrum of human vision adaptation. Consideration of the daylighting of a building can increase productivity in space. Something important, daylight provides tremendous psychological benefits to the residents of the building, it should be of prime concern because it can reduce the burden of artificial lighting requirements [1].

The extent and distribution of natural light in a room depends on three factors: Geometry of space, placement and orientation of windows and other openings and the characteristics of the internal surface. Design in form factor to accommodate daylight illumination requirements for activities in space and aims aesthetics of lighting design [2]. Natural light or daylight is a natural lighting coming from the whole ball bright sky, cloudy, wherein the heavens role as disseminator (diffuser) for the sunlight reaching it. Measurement values can be expressed with natural lighting Daylight Factor (DF). The amount of light can be measured by: [3]

- Using the value of luminance (flux, illumination), that is by assuming the light from the outdoors and calculates illuminance existing interior
- Using the relative magnitudes (daylight factor), that is by calculating the ratio of illuminance on the measuring point in space to the outdoor illuminance. DF value is fixed so if the bright light outside the room, then in the light as well, and vice versa, if the outside dim the inside too dim.

DF value, as the reference natural lighting condition, grouped by function space is as follows :

- Activity residence DF value by 1% to 2%,
- Activity office building DF value of 2% to 4%

Nomenclature

DF	Daylight Factor
E_i	E (Ilumination) Indoor
E_o	E (Ilumination) Outdoor
SC	Sky Component
ERC	Externally Reflected Component
IRC	Internally Reflected Component

2. Daylight Factor

2.1. Natural lighting

Natural lighting is the lighting that comes from nature, which naturally exist in nature. For example: sunlight, moonlight, stars. Areas of natural lighting during the day is a comparison of the level of lighting at a point of a particular field in a space on a flat field illumination level in the open field, which is a measure of the performance of the skylight room.

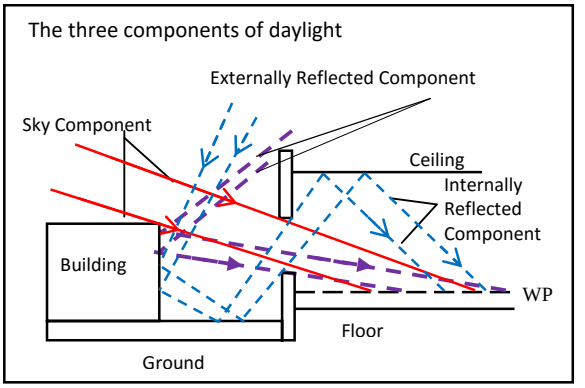


Fig. 1 Three components Daylight Factor

2.2. Factor Natural Lighting

Is a comparison of the level of lighting at a point of a particular field in a space on a flat field illumination level in an open field which is a measure of the performance of the room skylight. Factor natural lighting during the day consists of three components include: [4]

- Sky Component (SC), the lighting components directly from the sky light
- Externally Reflected Component (ERC), which is a component of lighting coming from the reflection of objects that are in the vicinity of the building concerned
- Internally Reflected Component (IRC), which is a component of lighting coming from the reflection surfaces in the room

Daylight Factor is defined as :

$$DF = \left(\frac{E_I}{E_O}\right) \times 100\% \quad (1)$$

Where,

Ei = caused daylight illumination at a point in the plane of work in this room
Eo = simultaneous outdoor illuminance on the horizontal plane of cleavage unobstructed overcast skies

2.3. Natural Lighting Systems in Buildings

In general, natural light is distributed into the room through openings in addition to (side lighting), opening at the top (top lighting), or a combination of both. Building types, heights, building and planning mass ratio, and the presence of other buildings around an electoral considerations lighting strategy. The lighting system side (side lighting) is a natural lighting system most widely used in buildings. In addition to entering light, also provide flexibility to view, orientation, connectivity outside and inside, and the air vents. The position of the window in the wall can be divided into three: high, medium, low, whose application is based on the needs of the distribution of light and wall systems.To find out how much light coming into the room as a reference qualified or not, and how to measure it can use luxmeter tool in every corner of the room in a test. [5]

Extreme conditions will occur on June 21 when the north pole is closest to the direction of the sun and on 21 December where the north pole is at its farthest from the sun. On September 21 and March 21 the sun was right

above the equator. So that the most effective time to conduct test measurements sunlight is three hours prior to 12:00 am, 12:00 am, and after at 12.00 am. [5,6]

3. Methodology

3.1. Data acquisition

This study evaluates the lighting distribution process through the data retrieval with the aid of a luxmeter on the object of study. The data can be analyzed to see the distribution of illumination in the room. His method is to make estimates is to create a mathematical equation "DF Estimation Based Sampling Data using weightings Distance".

1) Lux meter digital HS 6612 Dekko

Lux meter dekko 6612 HS digital is one tool type gauges the intensity of light or lighting levels used in this study. The lighting requirements of each room is sometimes different. All depends and adapted to the working activities. To measure the light levels needed an instrument that could work automatically capable of measuring light intensity and adjusts the light required.

Fig. 2 lux meter dekko 6612HS

This tool can present a digital format uses the measurement results. Different types of light entering the luxmeter either natural light or artificial light will have a different response from the sensor. Various colors are measured will produce different color temperatures and different wavelengths, the value generated by luxmeter of the numbers called illumination. Measurements on units of study conducted at 08.00 am, 12.00 am and 15.00 pm to take advantage of natural light where sun shines bright light conditions.

2) Object Study

Data retrieval studies that are in one of the rooms, studios, apartment buildings Puncak Kertajaya Surabaya, located on the 8th floor, orientation longest building on the north and south. The room was on the field in a tower with a view to the south. Height of the rooms from floor is 21 meters from the ground floor (Where height is 3 m per floor, on the floor of the apartment no 4 was removed, then the position of the object of study is actually located on the 7th floor position).

Characteristic studio type rooms on the study object has an area of 18 m², ceiling height of 3 m, has two windows with clear glass on the south field with an orientation toward the inside of the inner court of the building mass (tower). The rooms have white color made standard on the ceilings, floors and walls. In this studio-type unit has one bathroom and a small kitchen that is located between the entrance. This unit also has a small balcony the size of 1:25 m x 0.85 m. The size of the two windows on the type, measuring 0.60 m x 1:50 m (window position 0.5 m from the floor) on the side wall of the balcony section and measuring 0.75 m x 0.80 m (window position 1m from the floor) on the side wall next to it. (as shown in Fig. 5).

Fig. 3 Typical mass of the building and room position (red arrow)

Fig. 4. Typical studio room

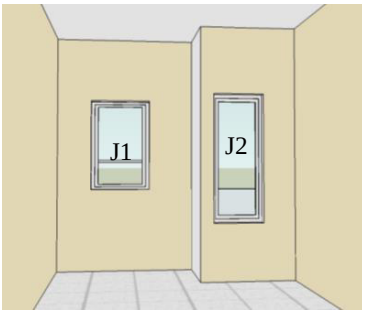


Fig. 5. The position of the window

3) The division Gred and Value Studies Point Sample

To facilitate decision-sampling point in the room, determined by per 1 m² coordinates and the coordinates of each point within 1m. Giving the name of the measurement point will make it easier to determine the test point by using the symbol T1 - T13. Recording the value of strong light (lux) luxmeter premises was conducted in March. Because in the months of March, June, September, December, this is the maximum of sunlight is shining, and done after the simulation will see results that any part that gets maximum light and which part is not getting light to the maximum.

Large Lux in each coordinates will differ from one another because of the incoming light will be very different because of the future then the light will be brighter, if more and more into the light that may be on the wane. It is also influenced by the exposure time and the weather. Lighting distribution on the study is also influenced by the position and typical windows. For more details can be seen in the image below:

3.2. Sampling Method

To make an estimation of the distribution of light in the room to do some stage; Sampling Points Daylight

At this stage, the measurement of the power of light by means of luxmeter in the grids that have been planned, ie per 1 m² of field space. Measurements carried out at 8:00, 12:00 am and 15:00 pm with bright sun conditions. At this stage there are several things that affect the measurement that is, if suddenly the brightness of daylight conditions cloudy thereby affecting the power level of light.

There are 13 large measurement point of the bedroom space 18 m². Furthermore, in the image data processing plan, 13 of the grid, divided into a grid with a grid size of 0.25 m², it aims to make an estimate of the density distribution of daylight coming into the room. At T2 measurements may of 1600 lux value as the value of outdoor illumination (Eo).

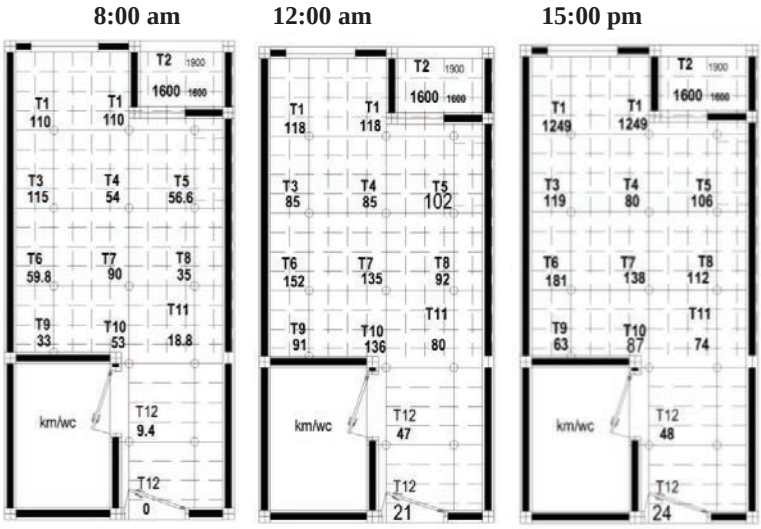


Fig. 6. Point measurement sample

3.3. Estimation Daylight

1) Estimates Daylight distribution

At this stage is to process the measurement data by plotting the distance between one point of the sample with dots estimates have been reduced.

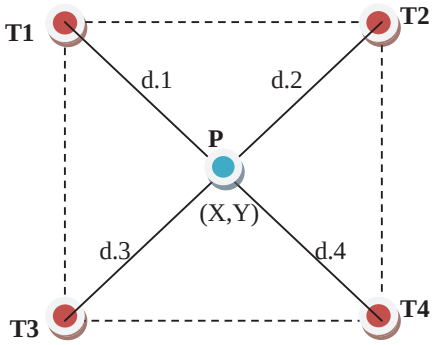


Fig. 7. The principle of the point estimate of the distance to the point of sample illumination

2) Formulate a mathematical equation

At this stage makes mathematical equation to find the weight distribution points within a light lunch on the object of study by the method Quadratic Equation-Based Distribution Distance intensity of tubes.

$$\boldsymbol{I} = \frac{\sum_{i=1}^{4} li \cdot \frac{1}{di^2}}{\sum_{i=1}^{4} \frac{1}{di^2}} \tag{2}$$

where,

$$di = \sqrt{(X_1^{'} - X)^2 + (Y_1^{'} - Y)^2} \tag{3}$$

3) The stage of entering data into a mathematical equation

Through mathematical equations above, the data entered at each sample point coordinates. Then can the figures based on the coordinates that exist in Floor Plan in the apartment. There is one Trends of the value of the distribution of natural lighting in the estimate are: "the closer the point estimates point to a sample, the illumination value closer to the value of sample points". (as shown in Fig. 8,9,10, the value of the sample points are marked with hatching)

110	110	108	106	107	110					
111	111	107	103	103	103					
113	113	104	97	90,5	82,2					
114	114	106	92	73,6	61,1					
110	115	106	83	61,5	54,0	55,3	56,3	55,9	56,0	54,
103	108	98	82	67,2	57	57,6	57,1	55,5	53,4	51,
87	87,0	82,8	80	76,2	67,6	64,6	59	52,9	45,5	45,
70,5	66,0	70,1	77,3	83,0	82,9	75,5	60,4	46,5	37,6	39,
57	59,0	60,4	69	83,5	90,0	80,8	58,0	39,8	35,0	33,
53,6	55,8	59,2	65,8	76,8	81,5	72,5	55,0	41,4	32,9	31,
46	46,0	53,1	58,8	64,4	64,0	59	49,0	39,0	26,5	26,
38,4	36,2	43,3	51,8	55,7	54,1	51,9	43,0	30,2	20,1	21,
35,1	33,0	38,0	48,3	53,2	53,0	46,2	31,2	20,5	18,0	17,
					45,9	39,4	28,3	20,9	16,9	16,
					28,3	26,3	22,5	18,6	13,7	13,
					13,7	15,8	16,7	13,7	10,5	11,
					9,4	8,6	7,8	8,6	9,4	8,6
					8,2	7,5	6,8	7,5	8,2	7,5
					4,7	4,7	4,7	4,7	4,7	4,7
					1,2	1,9	2,6	1,9	1,2	1,9
					0,0	0,8	1,6	0,8	0,0	0,8

Fig. 8. Assuming a value of illumination at 8:00 am

115	118	115	113	115	118					
111	114	111	109	111	114					
102	102	102	102	102	103					
92	89	92	94	92	90					
90	85	90	95	90	85	89	97	101	102	101
99	93	98	101	97	91	94	99	101	101	100
119	119	116	114	112	108	106	104	101	97	97
138	144	136	127	127	127	120	108	99	93	94
147	152	147	139	135	135	129	113	97	92	91
139	144	141	135	134	131	125	112	99	91	90
122	122	125	129	132	127	122	111	100	86	86
104	99	108	122	131	132	125	110	93	81	82
96	91	100	119	132	136	124	98	82	80	77
					122	110	91	81	76	73
					87	84	78	71	64	64
					56	61	64	58	51	54
					47	45	43	45	47	45
					44	42	40	42	44	42
					34	34	34	34	34	34
					24	26	28	26	24	26
					21	23	25	23	21	23

Fig. 9. Assuming a value of illumination at 8:00 am

1157	1249	1155	1057	1155	80					
1016	1108	1013	930	1011	88					
684	684	679	674	670	109					
352	260	346	419	326	130					
124	119	119	110	90	80					
132	127	123	116	100	88	93	102	106	107	107
150	150	139	130	120	109	109	109	109	109	109
168	173	160	143	135	130	125	116	112	111	111
171	181	168	145	137	138	131	118	112	112	112
157	166	153	136	131	130	123	113	109	107	104
122	122	119	117	115	109	107	103	98	93	93
87	78	87	98	97	92	94	93	85	79	82
73	63	73	89	90	87	83	77	74	74	77
					82	79	75	74	71	69
					69	69	71	72	61	61
					54	59	66	72	51	53
					48	46	44	46	48	50
					45	43	41	43	45	43
					36	36	36	36	36	36
					27	29	31	29	27	29
					24	26	28	26	24	26

Fig. 10. Assuming a value of illumination at 15:00 pm

4. Discussion and Result

4.1. Entering the data into the formula value Eo Daylight Factor.

In measuring the value of outdoor illuminance of 1600 lux there is a value which later as DF ratio of the value of Eo. Using the formula Daylight Factor (DF) can then estimate the distribution of the value of DF in the bedroom apartments. (as shown in Fig. 11a, 12a,13a)

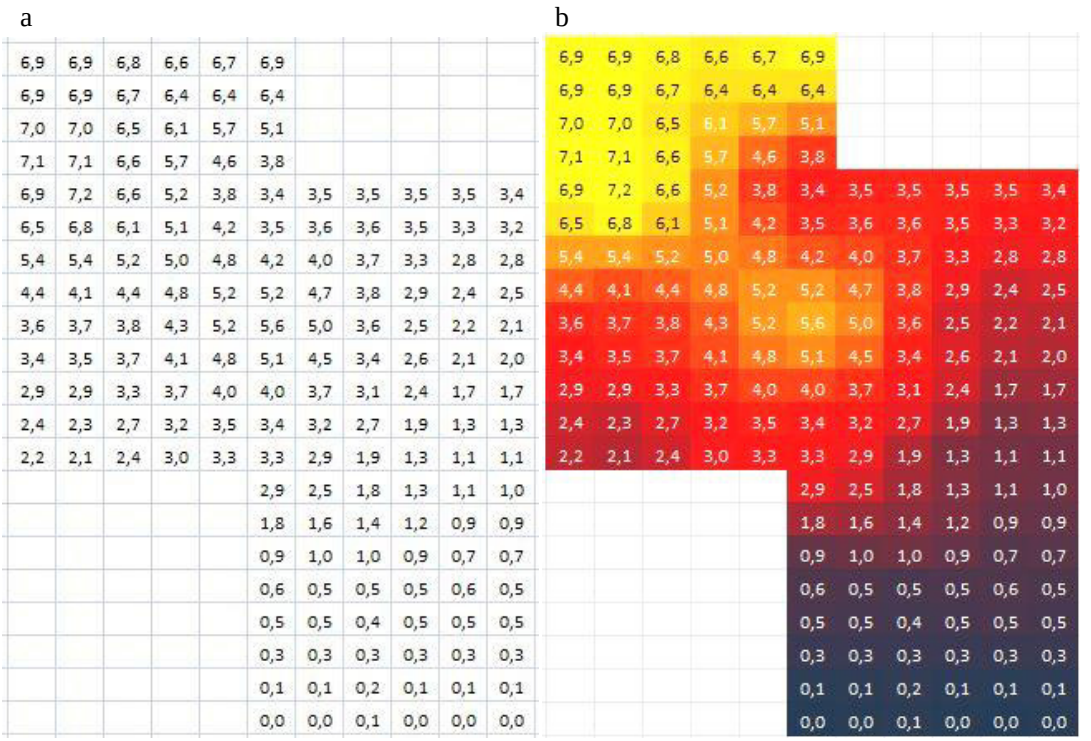
4.2. Final stage

The last stage is the estimated distribution Daylight Factor (DF) based on data estimated illuminance distribution by estimating the distance from one point to another at predetermined coordinates. The density of point estimate provides color grading on those coordinates.

1) 8:00 AM

In the picture can be seen DF distribution characterized by the transition of young yellow-orange color on the color indicates the value of DF interval of 5% - 7%. (as shown in Fig. 11b)

This area is located in the window that directly relate to the outside wall. On the transition of old orange color - red has a value of illumination interval of 3.2% -4.8%. If we look at this area is looking smaller than the yellow area, this is due to the windows contained in this area is not directly adjacent to the outer wall, and limited by the balcony. While in the transition area colored dark red - dark purple has a value of 0% -46% DF lux. In this area much smaller than the previous area, covering approximately 45% -50% of total living space area. This area is within 2-3 meters of openings field wall. DF value in this zone there is a small percentage of below 1%. This value indicates that this area does not meet the requirements of DF values for residential activities in which conditions, with a values to DF by 1% -2%.



6,9	6,9	6,8	6,6	6,7	6,9					
6,9	6,9	6,7	6,4	6,4	6,4					
7,0	7,0	6,5	6,1	5,7	5,1					
7,1	7,1	6,6	5,7	4,6	3,8					
6,9	7,2	6,6	5,2	3,8	3,4	3,5	3,5	3,5	3,5	3,4
6,5	6,8	6,1	5,1	4,2	3,5	3,6	3,6	3,5	3,3	3,2
5,4	5,4	5,2	5,0	4,8	4,2	4,0	3,7	3,3	2,8	2,8
4,4	4,1	4,4	4,8	5,2	5,2	4,7	3,8	2,9	2,4	2,5
3,6	3,7	3,8	4,3	5,2	5,6	5,0	3,6	2,5	2,2	2,1
3,4	3,5	3,7	4,1	4,8	5,1	4,5	3,4	2,6	2,1	2,0
2,9	2,9	3,3	3,7	4,0	4,0	3,7	3,1	2,4	1,7	1,7
2,4	2,3	2,7	3,2	3,5	3,4	3,2	2,7	1,9	1,3	1,3
2,2	2,1	2,4	3,0	3,3	3,3	2,9	1,9	1,3	1,1	1,1
					2,9	2,5	1,8	1,3	1,1	1,0
					1,8	1,6	1,4	1,2	0,9	0,9
					0,9	1,0	1,0	0,9	0,7	0,7
					0,6	0,5	0,5	0,5	0,6	0,5
					0,5	0,5	0,4	0,5	0,5	0,5
					0,3	0,3	0,3	0,3	0,3	0,3
					0,1	0,1	0,2	0,1	0,1	0,1
					0,0	0,0	0,1	0,0	0,0	0,0

Fig. 11. (a) assumptions distribution of DF value at 8.00 am ; (b) assumptions distribution of DF zone at 8:00 am

2) 12:00 AM

The windows are located on the south side is not exposed to direct natural lighting during the day. If you look at the estimated distribution of solar lighting, DF value in areas that are yellow - orange has a value interval of 7.5% - 9.5%. This area is located in the center of the room directly opposite the window field that borders the outside wall. DF distribution indicated by dark orange color - red value at intervals of 7.4% -5.2% . (as shown in Fig. 12b). This area tends there are around windows and surround the first area. While in the transition area colored dark red - dark purple has a value of illumination of 5.1% -1.3%. This area is located about 3-4 meters from the window. If viewed from the DF has the interval 1.3% - 7.4% have a standard requirement for the function DF occupancy.

3) 15:00 PM

Measurement at 15:00 pm today shows the distribution of natural lighting tends to be a great value. In the first area indicated by a yellow-orange color transitions young to have a value of 72% -41%. Great value DF is caused by externally reflected component (ERC), which is a component of lighting coming from the reflection of objects that are in the vicinity of the building concerned. This influence is produced by the reflection of the wall of the building mass south tower (reflection illumination afternoon) to the object of study (the north tower of the building). On the transition of old orange color - red has a value of DF interval 22% -4.5%. (as shown in Fig. 13b).The second area is located 4-4.5 meters from the window, precisely in the area of the kitchen. While in the transition area colored dark red - dark purple have DF values from 1.5 to 4.4%. This area tends to be closer to the entrance, located 5-5.5 meters from the window. DF value on the conditions at 15:00 pm has met the standard of value DF for residential functions.

a

7,2	7,4	7,2	7,0	7,2	7,4					
7,0	7,1	7,0	6,8	7,0	7,2					
6,3	6,3	6,3	6,3	6,3	6,4					
5,7	5,6	5,7	5,9	5,7	5,6					
5,7	5,3	5,6	5,9	5,6	5,3	5,6	6,1	6,3	6,4	6,3
6,2	5,8	6,1	6,3	6,0	5,7	5,9	6,2	6,3	6,3	6,2
7,4	7,4	7,3	7,1	7,0	6,7	6,6	6,5	6,3	6,1	6,1
8,6	9,0	8,5	8,0	7,9	8,0	7,5	6,7	6,2	5,8	5,9
9,2	9,5	9,2	8,7	8,4	8,4	8,1	7,0	6,1	5,8	5,7
8,7	9,0	8,8	8,4	8,4	8,2	7,8	7,0	6,2	5,7	5,6
7,6	7,6	7,8	8,0	8,2	8,0	7,6	6,9	6,2	5,4	5,4
6,5	6,2	6,8	7,6	8,2	8,2	7,8	6,8	5,8	5,1	5,2
6,0	5,7	6,2	7,4	8,3	8,5	7,7	6,1	5,2	5,0	4,8
					7,6	6,9	5,7	5,0	4,7	4,6
					5,4	5,2	4,8	4,5	4,0	4,0
					3,5	3,8	4,0	3,6	3,2	3,4
					2,9	2,8	2,7	2,8	2,9	2,8
					2,7	2,6	2,5	2,6	2,7	2,6
					2,1	2,1	2,1	2,1	2,1	2,1
					1,5	1,6	1,8	1,6	1,5	1,6
					1,3	1,4	1,6	1,4	1,3	1,4

b

7,2	7,4	7,2	7,0	7,2	7,4					
7,0	7,1	7,0	6,8	7,0	7,2					
6,3	6,3	6,3	6,3	6,3	6,4					
5,7	5,6	5,7	5,9	5,7	5,6					
5,7	5,3	5,6	5,9	5,6	5,3	5,6	6,1	6,3	6,4	6,3
6,2	5,8	6,1	6,3	6,0	5,7	5,9	6,2	6,3	6,3	6,2
7,4	7,4	7,3	7,1	7,0	6,7	6,6	6,5	6,3	6,1	6,1
8,6	9,0	8,5	8,0	7,9	8,0	7,5	6,7	6,2	5,8	5,9
9,2	9,5	9	8,7	8,4	8,4	8,1	7,0	6,1	5,8	5,7
8,7	9,0	8,8	8,4	8,4	8,2	7,8	7,0	6,2	5,7	5,6
7,6	7,6	7,8	8,0	8,2	8,0	7,6	6,9	6,2	5,4	5,4
6,5	6,2	6,8	7,6	8,2	8,2	7,8	6,8	5,8	5,1	5,2
6,0	5,7	6,2	7,4	8,3	8,5	7,7	6,1	5,2	5,0	4,8
					7,6	6,9	5,7	5,0	4,7	4,6
					5,4	5,2	4,8	4,5	4,0	4,0
					3,5	3,8	4,0	3,6	3,2	3,4
					2,9	2,8	2,7	2,8	2,9	2,8
					2,7	2,6	2,5	2,6	2,7	2,6
					2,1	2,1	2,1	2,1	2,1	2,1
					1,5	1,6	1,8	1,6	1,5	1,6
					1,3	1,4	1,6	1,4	1,3	1,4

Fig. 12. (a) assumptions Distribution DF value at 12.00 am; (b) assumptions distribution of DF zone at 12:00 am

a

72,3	78,1	72,2	66,1	72,2	5,0					
63,5	69,2	63,3	58,1	63,2	5,5					
42,8	42,8	42,4	42,1	41,9	6,8					
22,0	16,3	21,7	26,2	20,4	8,1					
7,8	7,4	7,4	6,8	5,6	5,0					
8,2	7,9	7,7	7,3	6,3	5,5	5,8	6,4	6,6	6,7	6,7
9,4	9,4	8,7	8,1	7,5	6,8	6,8	6,8	6,8	6,8	6,8
10,5	10,8	10,0	8,9	8,4	8,1	7,8	7,3	7,0	7,0	6,9
10,7	11,3	10,5	9,1	8,6	8,6	8,2	7,3	7,0	7,0	7,0
9,8	10,4	9,5	8,5	8,2	8,1	7,7	7,0	6,8	6,7	6,5
7,6	7,6	7,5	7,3	7,2	6,8	6,7	6,4	6,2	5,8	5,8
5,5	4,9	5,5	6,2	6,1	5,7	5,9	5,8	5,3	4,9	5,1
4,5	3,9	4,6	5,6	5,6	5,4	5,2	4,8	4,6	4,6	4,8
					5,1	4,9	4,7	4,6	4,4	4,3
					4,3	4,3	4,4	4,5	3,8	3,8
					3,4	3,7	4,2	4,5	3,2	3,3
					3,0	2,9	2,8	2,9	3,0	3,1
					2,8	2,7	2,6	2,7	2,8	2,7
					2,3	2,3	2,3	2,3	2,3	2,3
					1,7	1,8	1,9	1,8	1,7	1,8
					1,5	1,6	1,8	1,6	1,5	1,6

b

72,3	78,1	72,2	66,1	72,2	5,0					
63,5	69,2	63,3	58,1	63,2	5,5					
42,8	42,8	42,4	42,1	41,9	6,8					
22,0	16,3	21,7	26,2	20,4	8,1					
7,8	7,4	7,4	6,8	5,6	5,0					
8,2	7,9	7,7	7,3	6,3	5,5	5,8	6,4	6,6	6,7	6,7
9,4	9,4	8,7	8,1	7,5	6,8	6,8	6,8	6,8	6,8	6,8
10,5	10,8	10,0	8,9	8,4	8,1	7,8	7,3	7,0	7,0	6,9
10,7	11,3	10,5	9,1	8,6	8,6	8,2	7,3	7,0	7,0	7,0
9,8	10,4	9,5	8,5	8,2	8,1	7,7	7,0	6,8	6,7	6,5
7,6	7,6	7,5	7,3	7,2	6,8	6,7	6,4	6,2	5,8	5,8
5,5	4,9	5,5	6,2	6,1	5,7	5,9	5,8	5,3	4,9	5,1
4,5	3,9	4,6	5,6	5,6	5,4	5,2	4,8	4,6	4,6	4,8
					5,1	4,9	4,7	4,6	4,4	4,3
					4,3	4,3	4,4	4,5	3,8	3,8
					3,4	3,7	4,2	4,5	3,2	3,3
					3,0	2,9	2,8	2,9	3,0	3,1
					2,8	2,7	2,6	2,7	2,8	2,7
					2,3	2,3	2,3	2,3	2,3	2,3
					1,7	1,8	1,9	1,8	1,7	1,8
					1,5	1,6	1,8	1,6	1,5	1,6

Fig. 13. (a) assumptions distribution of DF value at 15.00 pm ; (b) assumptions distribution of DF zone at 15:00 pm

5. Conclusion

Based on the final results can be seen DF estimation "based on the intensity distribution of the square of distance" is by using an equation based on data within the study in the field. If we look at the distribution end estimates reflect changes color gradations of light and dark. The yellow color shows the bright light and dark tends to shift toward the inside. Distribution with a simple program is a preliminary study to show a pattern that occurs in lighting.

Estimated DF on the research can be seen in the distribution based on the value of illuminance outdoors compared to the value illuminance in the room based on the sampling points are taken by using luxmeter. The result can be seen at 8:00 am, DF value was lowest for the kitchen space. At the occupants will feel discomfort to perform activities in these areas.

From this simple research is expected to be the initial studies to be forwarded by using advanced methods. So it can help designers such as architects to design so that the lighting in the room, especially high-rise buildings such as apartments can distribute lighting tends to average by making the layout of the building.

Acknowledgements

The research was funded by Beasiswa Pendidikan Pascasarjana Dalam Negeri (BPP-DN) semester gasal 2015/2016 in RISTEKDIKTI Indonesia.

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